

(19)



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(11)

**EP 1 188 423 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention  
of the grant of the patent:  
**15.09.2004 Bulletin 2004/38**

(51) Int Cl.<sup>7</sup>: **A61F 2/44**

(21) Application number: **01204312.1**

(22) Date of filing: **10.06.1994**

**(54) Intervertebral disk arthroplasty device**

Arthroplastische Vorrichtung für Zwischenwirbelscheiben

Dispositif d'arthroplastie pour disque intervertébral

(84) Designated Contracting States:  
**AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL  
PT SE**

(30) Priority: **05.04.1994 US 223119**

(43) Date of publication of application:  
**20.03.2002 Bulletin 2002/12**

(60) Divisional application:  
**04075446.7 / 1 421 922**

(62) Document number(s) of the earlier application(s) in  
accordance with Art. 76 EPC:  
**94923190.6 / 0 754 018**

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## Description

### BACKGROUND OF THE INVENTION

**[0001]** The present invention is directed to a surgical joint replacement device; particularly, a replacement for a degenerated or ruptured disk between consecutive vertebrae in the spine.

**[0002]** Currently there are approximately 60,000 lumbar spine fusions performed in the United States and 30,000 lumbar fusions performed in Canada each year. Spinal fusion is frequently used as a treatment for low back pain and intervertebral disk degeneration, and the use of internal fixation has increased the ability of a surgeon to obtain a solid fusion. There is increased concern, however, that the biomechanical rigidity of the fusion and internal fixation may predispose adjacent spinal motion segments to rapid deterioration. Long-term follow up of patients undergoing a successful fusion indicates that 50 percent will continue to have complaints of pain. As in other joints, alternatives to fusing a spinal motion segment have inherent advantages.

**[0003]** Researchers have attempted to design a successful intervertebral disk arthroplasty device for years. U.S. Patent 4,946,378 discloses an artificial disk having a pair of end bodies with a medical synthetic polymeric intermediate member held between the end bodies. The intermediate member apparently provides some flexibility. Somewhat similarly, U.S. Patent 5,002,576 discloses an artificial disk having end cover plates separated by a closed corrugated tube which is filled with a viscoelastic material, like a body-compatible silicone. Also, U.S. Patent No. 4,932,975 shows a vertebral prosthesis having a pair of end members that house suspension plates surrounded by an elastomeric medium. The end housings are interconnected with flexible and expandable bellows.

**[0004]** Other approaches are shown in U.S. Patent Nos. 4,349,921, 4,714,469, 4,759,769, 4,863,476, 4,936,848, 4,997,432, 5,047,055, 5,071,437 and PCT Patent WO 92/14423. U.S. Patent No. 4,349,921 discloses an artificial disk having convex superior and inferior surfaces corresponding to the adjacent vertebrae surfaces and being formed from two components to allow flexion and extension between the two components. U.S. Patent No. 4,714,469 discloses a single member artificial disk having a predetermined thickness. U.S. Patent No. 4,759,769 discloses an artificial disk having upper and lower members hinged together at a rear portion and biased apart at a front portion by stiff coil springs. U.S. Patent No. 4,863,476 discloses a two portion spinal implant that is expandable so as to increase the spacing between the adjacent vertebrae. U.S. Patent No. 4,936,048 shows an artificial disk having a spherical shape that is hollow and rigid. The sphere wall contains fenestrations, open to the sphere cavity, for placing bone fragments therein. U.S. Patent No. 4,997,432 shows an artificial disk having plates sepa-

rated by a sliding core body normally consisting of a synthetic material. U.S. Patent No. 5,047,055 discloses an artificial disk made from a hydrogel material having a specified compressive strength and, when hydrated, having the shape of a human disk. U.S. Patent No. 5,071,437 shows an artificial disk having two rigid endplates separated by, and connected to, an elastomeric core material having flexure properties similar to those of a human disk.

**[0005]** Finally, U.S. Patents 4,595,663, Re. 32,449 and 5,037,438 disclose the use of ceramic material, including zirconia, for applications such as a joint replacement.

**[0006]** There are certain basic criteria a successful intervertebral disk arthroplasty device must fulfill. Fatigue strength of the materials is of utmost importance. Since the average age of patients undergoing spinal fusion is 42 years old, the life span of the device should exceed 40 years. Assuming the average person experiences 2 million strides per year and 125,000 significant bends in the spine, a conservative estimate of the number of spinal loading cycles over the 40-year period would be 85 million cycles. To provide a factor of safety, the device should be designed to at least a fatigue limit of 100 million cycles.

**[0007]** In addition to such durability, the materials for a successful intervertebral disk arthroplasty device must be biocompatible. The amount of wear of the implant must be kept to a minimum. Although the implant should be small enough to be contained within the anatomic confines of a normal disk space, it is recognized that it may be advantageous to increase the prosthetic disk height in order to over distract the disk space to unload the facet joints posteriorly.

**[0008]** The present invention not only satisfies these criteria, but it is anticipated that it could be a successful arthroplasty in place of 90 percent of the fusions currently being performed.

**[0009]** An intervertebral disk arthroplasty device as defined in the preamble of claim 1 is disclosed in US-A-5 258 031.

### SUMMARY OF THE INVENTION

**[0010]** The present invention is directed to an intervertebral disk arthroplasty device as defined in claim 1. With respect to a space created by a resected disk from between first and second vertebrae, the first member fits adjacent the first vertebrae and the second member fits adjacent the second vertebrae so that the ball portion fits in the socket portion.

**[0011]** In one embodiment, a first base plate having a first tab is fastened to the first member and a second base plate having a second tab is fastened to the second member. Screws are passed through the first and second tabs to fasten the base plates, and their corresponding first and second members, to the adjacent vertebrae.

**[0012]** The insert cups are preferably made of titani-

um. The use of titanium insert cups offers several advantages, including: (1) providing tensile support to the structure and maintaining the first and second member material in compression, (2) providing for the attachment of resisting fins to the anterior ends of the outer surface of an insert cup to further resist axial rotation by known processes such as machining, soldering, welding or gluing, (3) providing a surface that coatings may easily adhere to, such as a titanium bead coating for promoting bony ingrowth fixation using known technologies such as sintering or spraying and (4) providing a structure wherein the first and second members can remain a single size while the insert cup sizes may be more easily and cheaply varied by either adding or reducing metal thickness.

**[0013]** The invention also contemplates instances where initial screw fixation may not be necessary. It has been shown that bone ingrowth can occur into ceramic. Thus, in one aspect of the invention, a preferred material for the first and second members is zirconium oxide ceramic or aluminum oxide ceramic. The indicated ceramic is biocompatible and the fatigue strength is expected to provide the necessary number of design cycles for the indicated use. Wear would be minimal and the implant can be made small enough to fit within the anatomic confines of a normal disk space. Although zirconium oxide ceramic or aluminum oxide ceramic are presently preferred, it is understood that other materials may be found which will also satisfy performance needs.

**[0014]** In any case, with material criteria satisfied, the invention then further provides for movement with up to 3 degrees of freedom mimicking normal intervertebral disk movement, except for compression. In one preferred embodiment, the disk arthroplasty device is shaped to provide up to 15 degrees of flexion, 5 degrees of extension 5 degrees of lateral bending, while restricting anterior/posterior shear, axial rotation and axial compression movements. In another embodiment, the device is shaped to provide the 3 degrees of movement described above and to provide unlimited axial rotation. The inventive arthroplasty device is designed to be non-compressible in order to maintain distraction of the facet joints posteriorly, thereby reducing the likelihood of a source of possible pain.

**[0015]** The arthroplasty device is placed in a distracted disk space so that the surrounding soft-tissue, ie. disc annulus, is in tension, to prevent the arthroplasty device from dislocating. In this environment, the ball and socket portions as defined by the invention eliminate any loose moving parts, while still providing for the greatest flexibility of movement available.

**[0016]** Thus, the advantages and objects obtained by the present invention are many. Further explanation and understanding is available by reference to the drawings briefly described hereinafter and to the detailed description thereafter.

## BRIEF DESCRIPTION OF THE DRAWINGS

### [0017]

FIG. 1 is a front representation of a lumbar spine, showing healthy disks between vertebral bodies.

FIG. 2 is similar to FIG. 1, except a disk has been replaced by a prior art disk arthroplasty device.

FIG. 3 is a side cross-sectional view of a prior art disk arthroplasty device.

FIG. 4 is a front view of the device of FIG. 3.

FIG. 5 is a perspective view of a disk arthroplasty device in accordance with the present invention with the ball and socket configuration shown in phantom.

FIG. 6 is an anterior view of two vertebrae showing replacement of a human disk by a disk arthroplasty device in accordance with another embodiment of the present invention.

FIG. 7 is a side view of FIG. 5.

FIG. 8 is a perspective view of the lower member of a disk arthroplasty device in accordance with a further embodiment of the invention.

FIG. 9 is a perspective view of the upper member of a disk arthroplasty device with a socket configuration corresponding to the ball configuration of FIG. 8 shown in phantom.

FIG. 10 is a perspective view of the lower member of a disk arthroplasty device in accordance with a further embodiment of the invention with the ball configuration shown in phantom.

FIG. 11 is a perspective view of a disk arthroplasty device with a socket configuration corresponding to the ball configuration of FIG. 10.

FIG. 12 shows a top elevational view of a disk arthroplasty device with another ball configuration according to the present invention.

FIG. 13 is a cross-section of the disk arthroplasty device of FIG. 12 along section lines 13-13.

FIG. 14 is a cross-section of the disk arthroplasty device of FIG. 12 along section lines 14-14.

FIG. 15 is a top perspective view of an insert cup according to the present invention.

FIG. 16 is a side elevational view of the insert cup of FIG. 15.

FIG. 17 is a side elevational view of the insert cup of FIG. 15 with the lower member of a disk arthroplasty device mounted therein.

FIG. 18 is a top perspective view of another insert cup according to the present invention.

FIG. 19 is a side elevational view of the insert cup of FIG. 18.

FIG. 20 is a cross sectional view of a disk arthroplasty device mounted within a pair of insert cups of FIG. 18 and showing a screw attachment of the arthroplasty device to one of the insert cups.

FIG. 21 is an enlarged version of the circled area of FIG. 20 showing a screw attachment of a disk ar-

throplasty member to the insert cup of FIG. 18.

FIG. 22 shows a top perspective view of an insert cup incorporating rows of resisting teeth and a bead pocket.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

**[0018]** For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

**[0019]** Referring now to FIGS. 1 - 4 wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to FIG. 2, a prior art intervertebral disk arthroplasty device is designated generally by the numeral 10. Device 10 is shown implanted between a first vertebral body 12 above it and a second vertebral body 14 below it, all being part of a representative lumbar spinal column 16. Lumbar spine 16 is shown in FIG. 1 to include a healthy disk 18. Device 10 is a prosthetic disk replacement in the space created by resected disk 18.

**[0020]** As shown in FIGS. 3 and 4, disk arthroplasty device 10 includes an upper assembly 20 and a lower assembly 22. Upper assembly 20 includes a first member 24 having a socket 26 therein. A base plate 28 having an upwardly extending tab 30 therefrom is fastened to first member 24. First member 24 has an upper side 32 to conform with and be fastened to an adjacent side 34 of base plate 28. A side 36 opposite upper side 32 includes socket 26 formed therein. Side 36 is formed so that it slopes upwardly on all sides of socket 26 such that the sloping is away from the entrance to socket 26 and toward upper side 32.

**[0021]** Base plate 28 is essentially a flat plate fastened with a biocompatible adhesive or other fastening mechanism known to those skilled in the art along side 34 to side 32 of first member 24. The upper side 38 of base plate 28 is formed to conform with vertebral body 12. Generally, side 38 is flat, and the conforming side of vertebral body 12 is made flat during the surgery. Tab 30 extends upwardly and is integral with base plate 28. Tab 30 includes an opening 40 therethrough so that a screw 42 (shown with respect to lower base plate 48) can be used to fasten assembly 20 to vertebral body 12.

**[0022]** Lower assembly 22 includes a second member 44 having a ball 46 formed thereon which fits loosely into socket 26. Base plate 48 having tab 50 is similar to upper base plate 28 with tab 30 and need not be described further. First member 44 has a lower side 52 which is fastened to an adjacent side 54 of base plate

48 and in a similar fashion as earlier described with respect to first member 24 and upper base plate 28. A side 56 opposite from lower side 52 includes ball 46 extending upwardly therefrom. Side 56 slopes away from ball 46 on all sides of ball 46 so as to create space between first and second members 24, 44 except where they fit together at ball 46 and socket 26. In one preferred embodiment, sides 56 and 36 slope away from ball 46 and socket 26 along an inclined plane in four different directions. Ball 46 and socket 26 generally have an oval shape or an elongated shape with quarter spherical shapes at the ends.

**[0023]** A motion segment with respect to the present invention comprises a disk arthroplasty device 10 and adjacent upper and lower vertebral bodies. The exact contours of ball 46 and socket 26 and the surrounding surfaces of sides 36 and 56 determine the range of motion allowed in flexion and extension, side bending, shear and rotation of the motion segment.

**[0024]** The primary motion observed in a healthy lumbar intervertebral joint is flexion-extension. A typical L4-L5 intervertebral disk allows 13 degrees of flexion, 3 degrees of extension, 3 degrees of lateral side bending, 1 degree of axial rotation, and a small amount of shear. The center of rotation for flexion-extension is located in the posterior portion of the intervertebral disk space. The present invention is based on a concept of loose constraint. One preferred embodiment allows 3 degrees of freedom mimicking the normal intervertebral disk movements of flexion, extension and lateral bending. Axial rotation, anterior/posterior shear and axial compression are restricted by disk arthroplasty device 10 in order to protect the posterior facet joints. In addition, it is inserted by distracting the disk space which will place the surrounding soft tissue constraints in tension. This helps prevent the arthroplasty device from dislocating. The device is shaped to provide 15 degrees of flexion, 5 degrees of extension, 5 degrees of side bending, 5 degrees of rotation, and 2 millimeters of shear. The articulating surfaces are the concave female socket surface which articulates with the male concave ball surface. Such design eliminates loose moving parts.

**[0025]** The present invention contemplates the use of a material for the first and second members 24 and 44 that will result in low particulate generation and that will prevent axial movement in compression. This application appears to be well suited for ceramic materials and one preferred embodiment uses zirconium oxide as the ceramic material while another preferred embodiment uses aluminum oxide. The material specifications show ideal wear characteristics and biocompatibility. The modulus of elasticity is less than previously available ceramics, and is less prone to cracking. It would appear that the material would last the required 40 years as a replacement disk arthroplasty.

**[0026]** The prior art device shown in FIGS. 1 - 4 has the ceramic members 24 and 44 fastened to base plates made preferably from either chrome cobalt or titanium.

The purpose for the metal base plates is to enhance bone ingrowth for long-term fixation and to provide for short term fixation with screw attachments to adjacent vertebral bodies. However, it is understood that since device 10 is placed in distracted disk space wherein surrounding soft tissue constraints are in tension, that initial screw fixation may not be necessary. Furthermore, bone ingrowth has been shown to occur into ceramic. It is anticipated, therefore, that the entire disk arthroplasty device may be able to be made of only first and second members, 24 and 44, namely the two articulating pieces of ceramic.

**[0027]** An appropriate surgical technique for implantation of the present invention is described in a paper, incorporated herein by reference, entitled "Femoral Cortical Ring Plus Cancellous Dowel: An Alternative in an Anterior Lumbar Interbody Fusion" available from Richard M. Salib, M.D., Institute for Low Back Care, 2800 Chicago Avenue South, Minneapolis, Minnesota 55407.

**[0028]** FIGS. 5 - 14 show embodiments of a disk arthroplasty device according to the present invention. Referring to FIG. 5, a disk arthroplasty device 110, similar to that shown in FIGS. 1 - 4, is shown. The disk arthroplasty device 110 comprises an ellipsoidally-shaped ball 146 and socket 126, oriented so that their greatest lengths are disposed along a first axis transverse to the anterior and posterior ends 158 and 160 respectively and their shortest lengths are disposed along a second axis which is perpendicular to the first axis along surface 156. In one preferred embodiment, the radius of the ellipsoidal ball and socket configurations is 0,818 cm (0.322 inches) along the first axis and 0,439 cm (0.173 inches) along the second axis. In another embodiment, the radius of the ball and socket configurations is 1,095 cm (0.431 inches) along the first axis and 0,650 cm (0.256 inches) along the second axis. Generally, the greater the ball radii, the greater the resistance to compressive, rotational and axial shear loading.

**[0029]** The center of rotation 165 of the arthroplasty device 110 is located posteriorly, at 65 percent of the length between the anterior end 158 and posterior end 160, to match the normal lumbar spine center of rotation. The present invention further contemplates locating the device 110 center of rotation elsewhere to match centers of rotation in other areas of the spine.

**[0030]** As seen in FIGS. 5 and 7, the first joint surface 136 is sloped away from socket 126 while the second joint surface 156 remains flat. The degree of slope determines the amount of relative rotation between joint surfaces 136 and 156 respectively and the first joint surface 136 is sloped to provide for up to 5 degrees of lateral bending in either direction, up to 5 degrees of extension and up to 15 degrees of flexion. In the preferred embodiment, the first joint surface 136 is sloped to provide 5 degrees of lateral bending in either direction, 5 degrees of extension and 15 degrees of flexion. In this embodiment, ball 146 and socket 126 may be configured to have a predetermined fit to permit axial rotation

of up to 5 degrees in either direction as shown at 190 in FIG. 5. Any further rotation is inhibited due to the elongated nature of ball 146 and socket 126.

**[0031]** FIGS. 6 and 7 show the device arthroplasty device 110 of FIG. 5 positioned between a first and second vertebra 12 and 14 respectively. FIG. 6 shows an anterior view of device arthroplasty disk 110 in place of a natural disk and FIG. 7 shows a side view of the same. Both FIGS. 6 and 7 show the device arthroplasty device 110 of FIG. 5 in cross-section.

**[0032]** Referring now to FIGS. 8 and 9, another embodiment of the arthroplasty device of the present invention is shown. The device 210 ball 246 of FIG. 8 and socket 226 of FIG. 9 are spherically-shaped with partially cylindrical shapes at the transverse ends.

**[0033]** The center of rotation 2G5 of the arthroplasty device 210 is located posteriorly, at 65 percent of the length between the anterior end 258 and posterior end 260, to match the normal lumbar spine center of rotation. The present invention further contemplates locating the device 210 center of rotation elsewhere to match centers of rotation in other areas of the spine.

**[0034]** As seen in FIG. 9, the first joint surface 236 is sloped away from socket 226 while the second joint surface 256 remains flat. The degree of slope determines the amount of relative rotation between joint surfaces 236 and 256 respectively and the first joint surface 236 is sloped to provide for up to 5 degrees of lateral bending in either direction, up to 5 degrees of extension and up to 15 degrees of flexion. In the preferred embodiment, the first joint surface 236 is sloped to provide 5 degrees of lateral bending in either direction, 5 degrees of extension and 15 degrees of flexion. In this embodiment, ball 246 and socket 226 may be configured to have a predetermined fit to permit axial rotation of up to 5 degrees in either direction as shown generally at 170 for disk arthroplasty device 110. Any further rotation is inhibited due to the partially cylindrical shapes of ball 246 and socket 226.

**[0035]** Referring now to FIGS. 10 and 11, another embodiment of arthroplasty device 310 is shown wherein the ball portion 346 of FIG. 10 and corresponding socket portion 326 of FIG. 11 are comprised of three spherical shapes 346(a), 346(b), 346(c), 326(a), 326(b) and 326(c) respectively. Ball 346(a) and socket 326(a) are sized to be larger in radius than the respective (b) and (c) spheres and sockets. In addition, ball and socket portions 346(b), 346(c), 326(b) and 326(c) are sized to have equal radii and be equally spaced in transverse directions from ball and socket portions 346(a) and 326(a) as shown in FIGS. 10 and 11.

**[0036]** The center of rotation 365 of the arthroplasty device 310 is located posteriorly, at 65 percent of the length between the anterior end 358 and posterior end 360, to match the normal lumbar spine center of rotation. The present invention further contemplates locating the device 310 center of rotation elsewhere to match centers of rotation in other areas of the spine.

**[0037]** As seen in FIG. 11, the first joint surface 336 is sloped away from socket 326 while the second joint surface 356 remains flat. The degree of slope determines the amount of relative rotation between joint surfaces 336 and 356 respectively and the first joint surface 336 is sloped to provide for up to 5 degrees of lateral bending in either direction, up to 5 degrees of extension and up to 15 degrees of flexion. In the preferred embodiment, first joint surface 336 is sloped to provide 5 degrees of lateral bending in either direction, 5 degrees of extension and 15 degrees of flexion. In this embodiment, ball portion 346 and socket portion 326 may be configured to have a predetermined fit to permit axial rotation of up to 5 degrees in either direction as shown generally at 170 for disk arthroplasty device 110. Any further rotation is inhibited due to the location of ball 346 (b) and corresponding socket 326(b) and ball 346(c) and corresponding socket 326(c).

**[0038]** The design of FIGS. 10 and 11 permit the highest area of contact between ball portion 346 and socket portion 326 while maintaining the required constraint to axial rotation.

**[0039]** Referring now to FIGS. 12 - 14, another preferred embodiment of arthroplasty device 410 is shown wherein the ball 446 and socket 426 are spherically shaped. This embodiment permits virtually unrestrained rotation about the long axis of the spine. Under normal circumstances, rotation should be restricted to protect the facets. However, if only a small portion of the annulus is removed to insert disk arthroplasty device 410, the remaining annulus is believed to provide significant resistance to rotation, thereby allowing only normal physiological loading of the facets with this design. Restriction of axial rotation is therefore no longer necessary and the disk arthroplasty device may therefore allow 3 degrees of freedom mimicking the normal intervertebral disk movements of flexion/extension, lateral bending and axial rotation. Anterior/posterior shear, lateral shear and axial compression are restricted with this particular embodiment.

**[0040]** The center of rotation 465 of the arthroplasty device 410 is located posteriorly, at 65 percent of the length between the anterior end 458 and posterior end 460, to match the normal lumbar spine center of rotation. The present invention further contemplates locating the device 410 center of rotation elsewhere to match centers of rotation in other areas of the spine.

**[0041]** As seen in FIGS. 13 and 14, the first joint surface 436 is sloped away from socket 426 while the second joint surface 456 remains flat. The degree of slope determines the amount of relative rotation between joint surfaces 436 and 456 respectively and the first joint surface 436 is sloped to provide for up to 5 degrees of lateral bending in either direction, up to 5 degrees of extension and up to 15 degrees of flexion. In the preferred embodiment, the first joint surface is sloped to provide 5 degrees of lateral bending in either direction, 5 degrees of extension and 15 degrees of flexion.

**[0042]** Referring now to FIGS. 15 - 22, each embodiment of the disk arthroplasty device of the present invention may be fastened to insert cups before surgical implantation. Figs. 15 - 17 show one embodiment of an insert cup 70. The insert cup 70 is configured to be fastened to either the upper side of the first member, such as member 324, or the lower side of the second member, such as member 344 as shown in FIG. 17, at its surface 72 by press fitting a disk arthroplasty member within the insert cup. The present invention also contemplates other means for fastening the insert cup 70 to a disk arthroplasty device surface such as with a body-compatible adhesive, tape, solder attachment or clip mechanism. Insert cup 70 is provided with an engaging surface 76 for engaging either vertebral surface as shown in FIGS. 5 and 6. Engaging surface 76 is generally convexly shaped about an axis perpendicular to the spine as shown in FIG. 5. This configuration follows the natural contours of the top and bottom vertebrae surfaces and acts to stabilize the device with respect to axial rotation and anterior/posterior shear.

**[0043]** FIGS. 18 - 21 show another embodiment of insert cup 170 with a receiving surface 172 and flanges 174 for slidably receiving the outer surface of a first member, such as member 324, or the outer surface of a second member, such as member 344, as shown in FIG. 20. Insert cup 170 is provided with a convex engaging surface 176 for engaging either vertebral surface, identical to the embodiment shown by insert cup 70. A disk arthroplasty device member is attached to insert cup 170 by screwing the cup 170 to a member, such as member 344, as shown in FIG. 20. As shown in detail in FIG. 21, the screw 78 is counter-sunk through opening 80 in insert cup 170 and engages another opening 82 in member 344.

**[0044]** The preferred material for either insert cup 70 or 170 is a metal, such as titanium. The insert cups may be formed by a variety of known processes such as machining or molding and in one embodiment of the present invention, the insert cups are molded. Using titanium insert cups with a disk arthroplasty device of the present invention provides various benefits such as providing tensile support to the structure and maintaining the first and second member material in compression and providing a structure wherein the disk arthroplasty device members can remain a single size while the insert cup sizes may be more easily and cheaply varied by either adding or reducing metal thickness.

**[0045]** Another benefit of using titanium insert cups with a disk arthroplasty device is that the insert cups provide a surface to which resisting fins, spikes or teeth can be more easily attached than to ceramic. FIG. 6 shows the attachment of resisting fins 92 to the anterior ends of the outer surface of an insert cup. These fins act to enhance the resistance of an arthroplasty device to axial rotation and may be attached to the insert cups by known processes such as machining, soldering, welding and gluing. In one embodiment, the fins are welded

to the insert cups. FIG. 22 shows rows of teeth 94 affixed to the surface of insert cup 70 that allow easy insertion of the arthroplasty device into a disk space, but resist expulsion in the opposite direction. Although any of the aforementioned attachment processes may be used to attach the rows of teeth 94 to the insert cups, in one embodiment these teeth are formed into during the machining process of the insert cups.

**[0046]** Yet another benefit of using titanium insert cups with a disk arthroplasty device is that insert cups provide a surface that coatings may easily adhere to. FIGS. 6 and 7 show the application of a titanium bead coating 90 to the outer surfaces of the insert cups to promote bony ingrowth fixation. A variety of known technologies may be used to apply a coating such as sintering or spraying and in one embodiment, the titanium bead coating 90 is sprayed onto the outer surface of the insert cups. FIG. 22 shows a bead pocket 96 that is provided between the sets of teeth rows 94, for receiving a coating of titanium beads. In the embodiment of FIG. 22, the rows of teeth resist expulsion of the disk arthroplasty device opposite to the direction of device insertion. The titanium bead coating disposed within bead pocket 96 then promotes bony ingrowth fixation which acts to hold the outer surface of the insert cups in place and to enhance resistance to movement of the insert cups in any direction.

**[0047]** While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the scope of the invention are desired to be protected.

## Claims

1. An intervertebral disk arthroplasty device (110, 210, 310, 410) adapted to replace a disk between a first vertebra and a second vertebra in the spine, said arthroplasty device comprising:

a first member for engaging the first vertebra having a first joint surface, a first posterior end and a first anterior end, said ends defining a transverse midline therebetween, said midline being equidistant from said first posterior end and said first anterior end;  
a second member for engaging the second vertebra having a second joint surface facing said first joint surface, and second posterior and anterior ends juxtaposed with corresponding ones of said first posterior and anterior ends; and  
a ball and socket joint (146, 126; 246, 226; 346, 326; 446, 426) between said first and second members defined in said first and second joint

surfaces and disposed between said midline and said first posterior end, said ball and socket joint configured to permit relative rotation between said first member and said second member about a first axis parallel to said transverse midline and a second axis perpendicular to said first axis and lying in a sagittal plane of the spine, wherein one (136, 236, 336, 436) of said first and second joint surfaces is inclined away from said ball and socket joint toward its respective first or second joint surface, entirely around said joint, characterized in that the other (156, 256, 356, 456) of said first and second joint surfaces is substantially flat around said joint.

2. The intervertebral disk arthroplasty device of claim 1, wherein said inclined surface includes a first inclined face extending from said first axis to said anterior end at a first angle, a second inclined face extending from said first axis to said posterior end at a second angle, third and fourth inclined faces extending from said second axis in opposite directions away from said second axis and parallel to said first axis at third and fourth angles respectively, said first, second, third and fourth angles being measured relative to the other of said first and second joint surfaces.
3. The intervertebral disk arthroplasty device of claim 2, wherein said third and fourth angles are sized to permit relative rotation up to a first predetermined angle between said first and second members about said second axis before said first joint surface contacts said second joint surface.
4. The intervertebral disk arthroplasty device of claim 3, wherein said second angle is sized to permit relative rotation between said first and second members, up to a second predetermined angle in the direction of said posterior ends, about said first axis before said first joint surface contacts said second joint surface.
5. The intervertebral disk arthroplasty device of claim 4, wherein said first angle is sized to permit relative rotation between said first and second members, up to a third predetermined angle in the direction of said anterior ends, about said first axis before said first joint surface contacts said second joint surface.
6. The intervertebral disk arthroplasty device of claim 5, wherein said ball and socket joint includes a ball portion defined on said first joint surface of said first member along said first axis and a socket portion correspondingly defined in said second joint surface of said second member to receive said ball portion therein.

7. The intervertebral disk arthroplasty device of claim 6, wherein said ball portion is elongate and circular in cross section along said first joint surface.
8. An intervertebral disk arthroplasty device according to claim 1, wherein said ball and socket joint is elongate and includes
  - a ball portion defined on said first joint surface of said first member and elongated along said first axis, and
  - a socket portion correspondingly defined in said second joint surface of said second member for receiving said elongated ball portion therein with a predetermined fit to permit a predetermined relative rotation between said first and second members about said second axis before said elongated ball portion contacts said corresponding socket portion.
9. The intervertebral disk arthroplasty device of claim 8, wherein said elongated ball and socket portions are ellipsoidal in cross section in a plane parallel to said first joint surface.
10. The intervertebral disk arthroplasty device of claim 8, wherein said elongated ball and socket portions are partially circular in cross section in a plane parallel to said first joint surface and include opposite ends formed in a partially cylindrical shape.
11. The intervertebral disk arthroplasty device of claim 8, wherein said elongated ball and socket joint includes a plurality of separate ball portions and corresponding socket portion.
12. The intervertebral disk arthroplasty device of claim 11, wherein said plurality of ball and socket portions include:
  - a first ball and socket portion; and
  - second and third ball and socket portions spaced on opposite sides of said first ball portion and equidistant from said first ball portion.
13. The intervertebral disk arthroplasty device of claim 12, wherein said first, second and third ball portions are circular in cross section in a plane parallel to said first joint surface, said first ball portion having a radius greater than the radii of said second and third ball portions.
14. The intervertebral disk arthroplasty device of claim 13, wherein said second and third ball portions have equal radii.
15. The intervertebral disk arthroplasty device according to claim 1, wherein the
  - first member has a top surface opposite said first joint surface, and the second member has a bottom surface opposite said second joint surface, and the device further comprises a first insert cup having a first receiving surface for receiving said top surface therein, and a first engaging surface opposite said first receiving surface for engaging the first vertebra; and
  - a second insert cup having a second receiving surface for receiving said bottom surface therein, and a second engaging surface opposite said second receiving surface for engaging the second vertebra, the said first and second engaging surfaces being convex about the sagittal plane of the spine.
16. The intervertebral disk arthroplasty device of claim 15, further including:
  - means for restrainably retaining said top and bottom surfaces within said first and second receiving surfaces respectively.
17. The intervertebral disk arthroplasty device of claim 16, wherein said means for restrainably retaining comprises a press fit.
18. The intervertebral disk arthroplasty device of claim 16, wherein said top, bottom, first receiving and second receiving surfaces are configured to permit said first and second members to be slidably received within said first and second insert cups respectively.
19. The intervertebral disk arthroplasty device of claim 18, wherein said means for restrainably retaining includes:
  - a first screw orientated in a direction perpendicular to said top surface from said first insert cup toward said first member, and engaging said first insert cup to said first member; and
  - a second screw orientated in a direction perpendicular to said bottom surface from said second insert cup toward said second member, and engaging said second insert cup to said second member.
20. The intervertebral disk arthroplasty device of claim 15, further including:
  - a plurality to resisting means for resisting axial rotation of said intervertebral disk arthroplasty device, said resisting means extending from the anterior ends of said first and second engaging surfaces, and perpendicular to said top and bottom surfaces.
21. The intervertebral disk arthroplasty device of claim



20, further including:

a coating disposed on said first and second engaging surfaces wherein said coating is a biologically acceptable material suitable for promoting bony ingrowth fixation.

22. The intervertebral disk arthroplasty device of claim 21, wherein said material is composed of titanium beads.

23. The intervertebral disk arthroplasty device according to claim 1, wherein the

first member has a top surface opposite said first joint surface, and the second member has a bottom surface opposite said second joint surface, and the device further comprises: a first insert cup having a first receiving surface for receiving said top surface therein, and a first engaging surface opposite said first receiving surface for engaging the first vertebra; a second insert cup having a second receiving surface for receiving said bottom surface therein, and a second engaging surface opposite said second receiving surface for engaging the second vertebra; and retaining ribs disposed on said top and bottom surfaces and extending parallel with the anterior and posterior ends of said first and second insert cups along said top and bottom surfaces, said retaining ribs being configured to permit movement of said disk arthroplasty device in the first direction and to resist movement of said disk arthroplasty device in an opposite direction.

24. The intervertebral disk arthroplasty device of claim 23, further including:

a first recessed channel in said top surface, said first channel extending parallel with said retaining ribs along said top surface, said first channel having a first predetermined width centred equidistant from the anterior and posterior ends of said first insert cup; and a second recessed channel in said bottom surface, said second channel extending parallel with said retaining ribs along said bottom surface, said second channel having a second predetermined width centred equidistant from the anterior and posterior ends of said second insert cup.

25. The intervertebral disk arthroplasty device of claim 24, further including:

a coating disposed within said first and second

recessed channels, wherein said coating is a biologically acceptable material suitable for promoting bony ingrowth fixation.

26. The intervertebral disk arthroplasty device of claim 15 or 23, wherein said first and second insert cups are made of titanium.

27. The intervertebral disk arthroplasty device of and preceding claim, wherein said first and second members are made of zirconia.

28. The intervertebral disk arthroplasty device of any preceding claim, wherein said first and second members are made of alumina.

29. The intervertebral disk arthroplasty device according to claim 1, wherein the ball and socket joint comprises

a first, second and third ball portion defined in said first joint surface of said first member, said ball portions having circular cross sections along an axis parallel to said transverse midline, said first ball portion having a larger radius than said second and third ball portions, said second and third ball portions having equal radii and being disposed on opposite sides of said first ball portion, said ball portions being disposed radially about said first axis; and a socket portion defined in said second joint surface substantially complementary to said ball portions in said first joint surface and configured to receive said ball portions therein; a first insert cup for inserting a surface of the first member opposite said first joint surface of said first member therein; and a second insert cup for inserting a surface of the second member opposite said second joint surface of said second member therein; each of said insert cups having a surface for engaging a respective vertebra of the first and second vertebra; and said engaging surfaces being disposed convexly about said second axis.

#### Patentansprüche

1. Zwischenwirbelscheiben-Arthroplastikvorrichtung (110, 210, 310, 410), geeignet zum Ersetzen einer Bandscheibe zwischen einem ersten Wirbel und einem zweiten Wirbel in der Wirbelsäule, wobei die Arthroplastikvorrichtung folgendes umfaßt:

ein erstes Element zum Eingriff mit dem ersten Wirbel, das eine erste Gelenkfläche, ein erstes posteriores Ende und ein erstes anteriores En-

- de hat, wobei die Enden eine Querhalbierende zwischen denselben definieren, wobei die Halbierende gleich weit von dem ersten posterioren Ende und dem ersten anterioren Ende entfernt ist,
- ein zweites Element zum Eingriff mit dem zweiten Wirbel, das eine zweite Gelenkfläche, die der ersten Gelenkfläche gegenüberliegt, und ein zweites posteriores und ein zweites anteriores Ende hat, die neben einem entsprechenden ersten posterioren und ersten anterioren Ende angeordnet werden, und
- ein Kugelgelenk (146, 126; 246, 226; 346, 326; 446, 426) zwischen dem ersten und dem zweiten Element, definiert in der ersten und der zweiten Gelenkfläche und angeordnet zwischen der Halbierenden und dem ersten posterioren Ende, wobei das Kugelgelenk so konfiguriert wird, daß es eine relative Drehung zwischen dem ersten Element und dem zweiten Element um eine erste Achse parallel zur Querhalbierenden und eine zweite Achse senkrecht zur ersten Achse und in einer Sagittalebene der Wirbelsäule liegend ermöglicht, wobei eine (136, 236, 336, 436) der ersten und der zweiten Gelenkflächen um das gesamte Gelenk herum von dem Kugelgelenk weg zu der jeweiligen ersten oder zweiten Gelenkfläche hin geneigt ist, **dadurch gekennzeichnet, daß** die andere (156, 256, 356, 456) der ersten und der zweiten Gelenkflächen um das Gelenk wesentlich flach ist.
2. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 1, bei der die geneigte Oberfläche eine erste geneigte Fläche, die in einem ersten Winkel von der ersten Achse zum anterioren Ende verläuft, eine zweite geneigte Fläche, die in einem zweiten Winkel von der ersten Achse zum posterioren Ende verläuft, eine dritte und eine vierte geneigte Fläche, die in einem dritten bzw. vierten Winkel von der zweiten Achse in entgegengesetzten Richtungen von der zweiten Achse weg und parallel zur ersten Achse verlaufen, wobei der erste, der zweite, der dritte und der vierte Winkel im Verhältnis zu der anderen der ersten und der zweiten Gelenkflächen gemessen werden.
  3. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 2, bei welcher der dritte und der vierte Winkel so bemessen werden, daß sie eine relative Drehung bis zu einem ersten vorher festgelegten Winkel zwischen dem ersten und dem zweiten Element um die zweite Achse ermöglichen, bevor die erste Gelenkfläche die zweite Gelenkfläche berührt.
  4. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 3, bei welcher der zweite Winkel so bemessen wird, daß er eine relative Drehung zwischen dem ersten und dem zweiten Element bis zu einem zweiten vorher festgelegten Winkel in der Richtung der posterioren Enden um die erste Achse ermöglicht, bevor die erste Gelenkfläche die zweite Gelenkfläche berührt.
  5. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 4, bei welcher der erste Winkel so bemessen wird, daß er eine relative Drehung zwischen dem ersten und dem zweiten Element bis zu einem dritten vorher festgelegten Winkel in der Richtung der anterioren Enden um die erste Achse ermöglicht, bevor die erste Gelenkfläche die zweite Gelenkfläche berührt.
  6. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 5, bei der das Kugelgelenk einen an der ersten Gelenkfläche des ersten Elements längs der ersten Achse definierten Kugelabschnitt und einen entsprechend in der zweiten Gelenkfläche des zweiten Elements zum Aufnehmen des Kugelabschnitts in demselben definierten Pfannenabschnitt einschließt.
  7. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 6, bei welcher der Kugelabschnitt länglich und von kreisförmigem Querschnitt längs der ersten Gelenkfläche ist.
  8. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 1, bei der das Kugelgelenk länglich ist und folgendes einschließt:  
einen Kugelabschnitt, definiert an der ersten Gelenkfläche des ersten Elements und länglich längs der ersten Achse, und  
einen Pfannenabschnitt, entsprechend definiert in der zweiten Gelenkfläche des zweiten Elements zum Aufnehmen des länglichen Kugelabschnitts in demselben mit einer vorher festgelegten Passung, um eine vorher festgelegte relative Drehung zwischen dem ersten und dem zweiten Element um die zweite Achse zu ermöglichen, bevor der längliche Kugelabschnitt den entsprechenden Pfannenabschnitt berührt.
  9. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 8, bei welcher der längliche Kugel- und der Pfannenabschnitt in einer Ebene parallel zur ersten Gelenkfläche einen ellipsenförmigen Querschnitt haben.
  10. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 8, bei welcher der längliche Kugel- und der Pfannenabschnitt in einer Ebene parallel

zur ersten Gelenkfläche einen teilweise kreisförmigen Querschnitt haben und gegenüberliegende Enden einschließen, die in einer teilweise zylindrischen Gestalt geformt werden.

- 11. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 8, bei der das längliche Kugelgelenk eine Vielzahl von gesonderten Kugelabschnitten und entsprechenden Pfannenabschnitten einschließt.**

- 12. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 11, bei der die Vielzahl von Kugel- und Pfannenabschnitten folgendes einschließt:**

einen ersten Kugel- und Pfannenabschnitt und einen zweiten und einen dritten Kugel- und Pfannenabschnitt, mit Zwischenraum an entgegengesetzten Seiten des ersten Kugelabschnitts und in gleicher Entfernung vom ersten Kugelabschnitt angeordnet.

- 13. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 12, bei welcher der erste, der zweite und der dritte Kugelabschnitt in einer Ebene parallel zur ersten Gelenkfläche einen kreisförmigen Querschnitt haben, wobei der erste Kugelabschnitt einen Radius hat, der größer ist als die Radien des zweiten und des dritten Kugelabschnitts.**

- 14. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 13, bei welcher der zweite und der dritte Kugelabschnitt gleiche Radien haben.**

- 15. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 1, bei der das erste Element eine obere Fläche gegenüber der ersten Gelenkfläche hat und das zweite Element eine untere Fläche gegenüber der zweiten Gelenkfläche hat und die Vorrichtung außerdem folgendes umfaßt:**

eine erste Einsatzschale mit einer ersten Aufnahme­fläche zum Aufnehmen der oberen Fläche in derselben und einer ersten Eingriffs­fläche gegenüber der ersten Aufnahme­fläche zum Eingriff mit dem ersten Wirbel, und eine zweite Einsatzschale mit einer zweiten Aufnahme­fläche zum Aufnehmen der unteren Fläche in derselben und einer zweiten Eingriffs­fläche gegenüber der zweiten Aufnahme­fläche zum Eingriff mit dem zweiten Wirbel, wobei die erste und die zweite Eingriffs­fläche um die Sa­gittalebene der Wirbelsäule konvex sind.

- 16. Zwischenwirbelscheiben-Arthroplastikvorrichtung**  
nach Anspruch 15, die außerdem folgendes ein-  
schließt:

**Mittel zum einspannbaren Festhalten der oberen und der unteren Fläche innerhalb der ersten bzw. der zweiten Aufnahme­fläche.**

- 5 17. Zwischenwirbelscheiben-Arthroplastikvorrichtung  
nach Anspruch 16, bei der das Mittel zum einspann-  
baren Festhalten eine Preßpassung umfaßt.

- 10 18. Zwischenwirbelscheiben-Arthroplastikvorrichtung  
nach Anspruch 16, bei der die obere, die untere, die  
erste Aufnahme- und die zweite Aufnahme­fläche  
dafür konfiguriert werden, daß sie ermöglichen, daß  
das erste und das zweite Element verschiebbar inner-  
halb der ersten bzw. der zweiten Einsatzschale  
15 aufgenommen werden.

- 19. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 18, bei der das Mittel zum einspannbaren Festhalten folgendes einschließt:**

eine erste Schraube, die in einer Richtung senkrecht zur oberen Fläche von der ersten Einsatzschale zum ersten Element hin ausgerichtet wird und die erste Einsatzschale mit dem ersten Element in Eingriff bringt, und eine zweite Schraube, die in einer Richtung senkrecht zur unteren Fläche von der zweiten Einsatzschale zum zweiten Element hin ausgerichtet wird und die zweite Einsatzschale mit dem zweiten Element in Eingriff bringt.

- 20. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 15, die außerdem folgendes einschließt:**

eine Vielzahl von Widerstandsmitteln, um einer Drehung der Zwischenwirbelscheiben-Arthroplastikvorrichtung in Axialrichtung zu widerstehen.

wobei sich die Widerstandsmittel von den anterioren Enden der ersten und der zweiten Eingriffsfläche und senkrecht zu der oberen und der unteren Fläche erstrecken.

- 21. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 20, die außerdem folgendes einschließt:**

einen auf der ersten und der zweiten Eingriffsfläche angeordneten Überzug, bei welcher der Überzug ein biologisch annehmbares Material ist, geeignet zum Fördern der Knocheneinwachsfixation.

- 22. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 21, bei der das Material aus Titanperlen besteht.**

23. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 1, bei der das erste Element eine obere Fläche gegenüber der ersten Gelenkfläche hat und das zweite Element eine untere Fläche gegenüber der zweiten Gelenkfläche hat und die Vorrichtung außerdem folgendes umfaßt:

eine erste Einsatzschale mit einer ersten Aufnahme­fläche zum Aufnehmen der oberen Fläche in derselben und einer ersten Eingriffs­fläche gegenüber der ersten Aufnahme­fläche zum Eingriff mit dem ersten Wirbel, eine zweite Einsatzschale mit einer zweiten Aufnahme­fläche zum Aufnehmen der unteren Fläche in derselben und einer zweiten Eingriffs­fläche gegenüber der zweiten Aufnahme­fläche zum Eingriff mit dem zweiten Wirbel, und Halterippen, die an der oberen und der unteren Fläche angeordnet werden und parallel zu den anterioren und den posterioren Enden der ersten und der zweiten Einsatzschale längs der oberen und der unteren Fläche verlaufen, wobei die Halterippen so konfiguriert werden, daß sie eine Bewegung der Bandscheiben-Arthroplastikvorrichtung in der ersten Richtung ermöglichen und einer Bewegung der Bandscheiben-Arthroplastikvorrichtung in einer entgegengesetzten Richtung widerstehen.

24. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 23, die außerdem folgendes einschließt:

einen ersten ausgesparten Kanal in der oberen Fläche, wobei der erste Kanal parallel zu den Halterippen längs der oberen Fläche verläuft, wobei der erste Kanal eine erste vorher festgelegte Breite hat, zentriert in gleichem Abstand von dem anterioren und dem posterioren Ende der ersten Einsatzschale, und

einen zweiten ausgesparten Kanal in der unteren Fläche, wobei der zweite Kanal parallel zu den Halterippen längs der unteren Fläche verläuft, wobei der zweite Kanal eine zweite vorher festgelegte Breite hat, zentriert in gleichem Abstand von dem anterioren und dem posterioren Ende der zweiten Einsatzschale.

25. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 24, die außerdem folgendes einschließt:

einen zwischen dem ersten und dem zweiten ausgesparten Kanal angeordneten Überzug, bei welcher der Überzug ein biologisch annehmbares Material ist, geeignet zum Fördern der Knocheneinwachsfixation.

26. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 15 oder 23, bei der die erste und die zweite Einsatzschale aus Titan hergestellt werden.

27. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach einem der vorhergehenden Ansprüche, bei der das erste und das zweite Element aus Zirkon­iumoxid hergestellt werden.

28. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach einem der vorhergehenden Ansprüche, bei der das erste und das zweite Element aus Alumi­niumoxid hergestellt werden.

29. Zwischenwirbelscheiben-Arthroplastikvorrichtung nach Anspruch 1, bei der das Kugelgelenk folgendes umfaßt:

einen ersten, einen zweiten und einen dritten Kugelabschnitt, definiert in der ersten Gelenk­fläche des ersten Elements, wobei die Kugel­abschnitte längs einer Achse parallel zur Quer­halbierenden einen kreisförmigen Querschnitt haben, wobei der erste Kugelabschnitt einen größeren Radius hat als der zweite und der dritte Kugelabschnitt und der zweite und der dritte Kugelabschnitt gleiche Radien haben und auf entgegengesetzten Seiten des ersten Kugelab­schnitts angeordnet werden, wobei die Kugel­abschnitte in Radialrichtung um die erste Achse angeordnet werden, und einen Pfannenabschnitt, definiert in der zweiten Gelenkfläche wesentlich komplementär zu den Kugelabschnitten in der ersten Gelenk­fläche und konfiguriert zum Aufnehmen der Kugelabschnitte in denselben, eine erste Einsatzschale zum Einsetzen einer Fläche des ersten Elements gegenüber der ersten Gelenkfläche des ersten Elements in dieselbe und eine zweite Einsatzschale zum Einsetzen einer Fläche des zweiten Elements gegenüber der zweiten Gelenkfläche des zweiten Elements in dieselbe,

wobei jede der Einsatzschalen eine Fläche zum Eingriff mit einem entsprechenden Wirbel des ersten und des zweiten Wirbels hat und

die Eingriffsflächen konvex um die zweite Achse angeordnet werden.

# Revendications

1. Dispositif d'arthroplastie de disque intervertébral (110, 210, 310, 410) destiné à remplacer un disque entre une première vertèbre et une deuxième vertèbre dans la colonne vertébrale, ledit dispositif

d'arthroplastie comprenant:

- un premier élément destiné à s'engager dans la première vertèbre, comportant une première surface d'articulation, une première extrémité postérieure et une première extrémité antérieure, lesdites extrémités définissant une ligne médiane transversale entre elles, ladite ligne médiane étant équidistante de ladite première extrémité postérieure et de ladite première extrémité antérieure;
- un deuxième élément, destiné à s'engager dans la deuxième vertèbre, comportant une deuxième surface d'articulation faisant face à ladite première surface d'articulation, et des deuxièmes extrémités postérieure et antérieure juxtaposées aux dites premières et deuxième extrémités postérieure et antérieure correspondantes; et
- une articulation à rotule et logement de rotule (146, 126; 246, 226; 346, 326; 446, 426) entre lesdits premier et deuxième éléments définie dans lesdites première et deuxième surfaces d'articulation et agencée entre ladite ligne médiane et ladite première extrémité postérieure, ladite articulation à rotule et logement de rotule étant configurée de sorte à permettre une rotation relative entre ledit premier élément et ledit deuxième élément autour d'un premier axe parallèle à ladite ligne médiane transversale et un deuxième axe perpendiculaire audit premier axe et situé dans un plan sagittal de la colonne vertébrale, l'une (136, 236, 336, 436) desdites première et deuxième surfaces d'articulation étant inclinée à l'écart de ladite articulation à rotule et logement de rotule, vers sa première ou deuxième surface d'articulation respective, entièrement autour de ladite articulation, caractérisé en ce que l'autre (156, 256, 356, 436) desdites première et deuxième surfaces d'articulation est pratiquement plate autour de ladite articulation.
2. Dispositif d'arthroplastie de disque intervertébral selon la revendication 1, dans lequel ladite surface inclinée englobe une première face inclinée s'étendant dudit premier axe vers ladite extrémité antérieure à un premier angle, une deuxième face inclinée s'étendant dudit premier axe vers ladite extrémité postérieure à un deuxième angle, des troisième et quatrième faces inclinées s'étendant à partir dudit deuxième axe dans des directions opposées à l'écart dudit deuxième axe et parallèlement audit premier axe, respectivement à des troisième et quatrième angles, lesdits premier, deuxième, troisième et quatrième angles étant mesurés par rapport à l'autre desdites première et deuxième surfaces d'articulation.

3. Dispositif d'arthroplastie de disque intervertébral selon la revendication 2, dans lequel lesdits troisième et quatrième angles sont dimensionnés de sorte à permettre une rotation relative jusqu'à un premier angle prédéterminé entre lesdites premier et deuxième éléments autour dudit deuxième axe avant que ladite première surface d'articulation contacte ladite deuxième surface d'articulation.
4. Dispositif d'arthroplastie de disque intervertébral selon la revendication 3, dans lequel ledit deuxième angle est dimensionné de sorte à permettre la rotation relative entre lesdits premier et deuxième éléments, jusqu'à un deuxième angle prédéterminé, dans la direction desdites extrémités postérieures, autour dudit premier axe, avant que ladite première surface d'articulation contacte ladite deuxième surface d'articulation.
5. Dispositif d'arthroplastie de disque intervertébral selon la revendication 4, dans lequel ledit premier angle est dimensionné de sorte à permettre la rotation relative entre lesdits premier et deuxième éléments, jusqu'à un troisième angle prédéterminé, dans la direction desdites extrémités antérieures, autour dudit premier axe, avant que ladite première surface d'articulation contacte ladite deuxième surface d'articulation.
6. Dispositif d'arthroplastie de disque intervertébral selon la revendication 5, dans lequel ladite articulation à rotule et logement de rotule englobe une partie de rotule définie sur ladite première surface d'articulation dudit premier élément le long dudit premier axe et une partie de logement de rotule définie de manière correspondante dans ladite deuxième surface d'articulation dudit deuxième élément pour recevoir ladite partie de rotule.
7. Dispositif d'arthroplastie de disque intervertébral selon la revendication 6, dans lequel ladite partie de rotule est allongée et a une section transversale circulaire le long de ladite première surface d'articulation.
8. Dispositif d'arthroplastie de disque intervertébral selon la revendication 1, dans lequel ladite articulation à rotule et logement de rotule est allongée et englobe
- une partie de rotule définie sur ladite première surface d'articulation dudit premier élément et allongée le long dudit premier axe; et
- une partie de logement de rotule définie de manière correspondante dans ladite deuxième surface d'articulation dudit deuxième élément pour recevoir ladite partie de rotule allongée par ajustement prédéterminé pour permettre une rotation relative prédéterminée entre lesdits premier et

deuxième éléments autour dudit deuxième axe avant que ladite partie de rotule allongée contacte ladite partie de logement de rotule correspondante.

9. Dispositif d'arthroplastie de disque intervertébral selon la revendication 8, dans lequel lesdites parties de rotule et de logement de rotule allongées ont une section transversale en ellipse dans un plan parallèle à ladite première surface d'articulation. 5
10. Dispositif d'arthroplastie de disque intervertébral selon la revendication 8, dans lequel lesdites parties de rotule et de logement de rotule allongées ont une section transversale partiellement circulaire dans un plan parallèle à ladite première surface d'articulation et englobent des extrémités opposées de forme partiellement cylindrique. 10 15
11. Dispositif d'arthroplastie de disque intervertébral selon la revendication 8, dans lequel ladite articulation à rotule et logement de rotule englobe plusieurs parties de rotule séparées et des parties de logement de rotule correspondantes. 20
12. Dispositif d'arthroplastie de disque intervertébral selon la revendication 11, dans lequel lesdites plusieurs parties de rotule et de logement de rotule englobent: 25
  - une première partie de rotule et de logement de rotule; et
  - des deuxième et troisième parties de rotule et de logement de rotule espacées sur les côtés opposés de ladite première partie de rotule et équidistantes de ladite première partie de rotule. 30 35
13. Dispositif d'arthroplastie de disque intervertébral selon la revendication 12, dans lequel lesdites première, deuxième et troisième parties de rotule ont une section transversale circulaire dans un plan parallèle à ladite première surface d'articulation, ladite première partie de rotule ayant un rayon supérieur aux rayons desdites deuxième et troisième parties de rotule. 40 45
14. Dispositif d'arthroplastie de disque intervertébral selon la revendication 13, dans lequel lesdites deuxième et troisième parties de rotule ont des rayons identiques. 50
15. Dispositif d'arthroplastie de disque intervertébral selon la revendication 1, dans lequel le premier élément comporte une surface supérieure opposée à ladite première surface d'articulation, le deuxième élément comportant une surface inférieure opposée à ladite deuxième surface d'articulation, le dispositif comprenant en outre 55

une première coupelle d'insertion comportant une première surface de réception pour recevoir ladite surface supérieure, et une première surface d'engagement opposée à ladite première surface de réception destinée à s'engager dans la première vertèbre; et

une deuxième coupelle d'insertion, comportant une deuxième surface de réception pour recevoir ladite surface inférieure, et une deuxième surface d'engagement opposée à ladite deuxième surface de réception destinée à s'engager dans la deuxième vertèbre, lesdites première et deuxième surfaces d'engagement étant convexes autour du plan sagittal de la colonne vertébrale.

16. Dispositif d'arthroplastie de disque intervertébral selon la revendication 15, englobant en outre:

un moyen pour retenir respectivement par restriction lesdites surfaces supérieure et inférieure dans lesdites première et deuxième surfaces de réception.

17. Dispositif d'arthroplastie de disque intervertébral selon la revendication 16, dans lequel ledit moyen de retenue par restriction comprend un ajustement par pression.

18. Dispositif d'arthroplastie de disque intervertébral selon la revendication 16, dans lequel lesdites surfaces supérieure et inférieure, ainsi que lesdites première et deuxième surfaces de réception sont configurées de sorte à permettre respectivement la réception par glissement desdits premier et deuxième éléments dans lesdites première et deuxième coupelles d'insertion.

19. Dispositif d'arthroplastie de disque intervertébral selon la revendication 18, dans lequel ledit moyen de retenue par restriction englobe:

une première vis orientée dans une direction perpendiculaire à ladite surface supérieure, de la première coupelle d'insertion vers ledit premier élément, et destinée à assurer l'engagement de ladite première coupelle d'insertion dans ledit premier élément; et  
une deuxième vis, orientée dans une direction perpendiculaire à ladite surface inférieure, de ladite deuxième coupelle d'insertion vers ledit deuxième élément, et destinée à assurer l'engagement de ladite deuxième coupelle d'insertion dans ledit deuxième élément.

20. Dispositif d'arthroplastie de disque intervertébral selon la revendication 15, englobant en outre:

plusieurs moyens de résistance destinés à ré-

- sister à la rotation axiale dudit dispositif d'arthroplastie de disque intervertébral, lesdites moyens de résistance s'étendant à partir des extrémités antérieures desdites première et deuxième surfaces d'engagement, perpendiculairement aux dites surfaces supérieure et inférieure. 5
21. Dispositif d'arthroplastie de disque intervertébral selon la revendication 20, englobant en outre: 10
- un revêtement agencé sur lesdites première et deuxième surfaces d'engagement, ledit revêtement étant composé d'un matériau biologiquement acceptable destiné à stimuler la fixation par croissance osseuse. 15
22. Dispositif d'arthroplastie de disque intervertébral selon la revendication 21, dans lequel ledit matériau est composé de billes de titane. 20
23. Dispositif d'arthroplastie de disque intervertébral selon la revendication 1, dans lequel le premier élément comporte une surface supérieure opposée à ladite première surface d'articulation, le deuxième élément comportant une surface inférieure opposée à ladite deuxième surface d'articulation, le dispositif comprenant en outre 25
- une première coupelle d'insertion comportant une première surface de réception pour recevoir ladite surface supérieure, et une première surface d'engagement opposée à ladite première surface de réception destinée à s'engager dans la première vertèbre; 30
- une deuxième coupelle d'insertion, comportant une deuxième surface de réception pour recevoir ladite surface inférieure, et une deuxième surface d'engagement opposée à ladite deuxième surface de réception destinée à s'engager dans la deuxième vertèbre, et 35
- des nervures de retenue agencées sur lesdites surfaces supérieure et inférieure et s'étendant parallèlement aux extrémités antérieure et postérieure desdites première et deuxième coupelles d'insertion, le long desdites surfaces supérieure et inférieure, lesdites nervures de retenue étant destinées à permettre le mouvement dudit dispositif d'arthroplastie intervertébral dans la première direction et à résister au mouvement dudit dispositif d'arthroplastie intervertébral dans une direction opposée. 40 45 50
24. Dispositif d'arthroplastie de disque intervertébral selon la revendication 23, englobant en outre: 55
- un premier canal évidé dans ladite surface supérieure, ledit premier canal s'étendant parallèlement aux dites nervures de retenue le long de ladite surface supérieure, ledit premier canal ayant une première largeur prédéterminée centrée à distance égale des extrémités antérieure et postérieure de ladite première coupelle d'insertion; et 60
- un deuxième canal évidé dans ladite surface inférieure, ledit deuxième canal s'étendant parallèlement aux dites nervures de retenue le long de ladite surface inférieure, ledit deuxième canal ayant une deuxième largeur prédéterminée centrée à distance égale des extrémités antérieure et postérieure de ladite deuxième coupelle d'insertion. 65
25. Dispositif d'arthroplastie de disque intervertébral selon la revendication 24, englobant en outre:
- un revêtement agencé dans lesdits premier et deuxième canaux évidés, ledit revêtement étant composé d'un matériau biologiquement acceptable approprié à stimuler la fixation par croissance osseuse. 70
26. Dispositif d'arthroplastie de disque intervertébral selon les revendications 15 ou 23, dans lequel lesdites première et deuxième coupelles d'insertion sont composées de titane. 75
27. Dispositif d'arthroplastie de disque intervertébral selon l'une quelconque des revendications précédentes, dans lequel lesdits premier et deuxième éléments sont composés de zircone. 80
28. Dispositif d'arthroplastie de disque intervertébral selon l'une quelconque des revendications précédentes, dans lequel lesdits premier et deuxième éléments sont composés d'aluminium. 85
29. Dispositif d'arthroplastie de disque intervertébral selon la revendication 1, dans lequel l'articulation à rotule et logement de rotule comprend:
- des première, deuxième et troisième parties de rotule définies dans ladite première surface d'articulation dudit premier élément, lesdites parties de rotule ayant des sections transversales circulaires le long d'un axe parallèle à ladite ligne médiane transversale, ladite première partie de rotule ayant un rayon supérieur à celui desdites deuxième et troisième parties de rotule, lesdites deuxième et troisième parties de rotule ayant des rayons identiques et étant agencées sur les côtés opposés de ladite première partie de rotule, lesdites parties de rotule étant agencées radialement autour dudit premier axe; et 90
- une partie de logement de rotule définie dans ladite deuxième surface d'articulation, prati-

quement complémentaire desdites parties de rotule dans ladite première surface d'articulation et destinée à recevoir lesdites parties de rotule; une première coupelle d'insertion pour insérer une surface du premier élément opposée à ladite première surface d'articulation dudit premier élément; et  
une deuxième coupelle d'insertion pour insérer une surface du deuxième élément opposée à ladite deuxième surface d'articulation dudit deuxième élément;  
chacune desdites coupelles d'insertion comportant une surface destinée à s'engager dans une vertèbre respective des première et deuxième vertèbres; et  
lesdites surfaces d'engagement étant agencées de manière convexe autour dudit deuxième axe.

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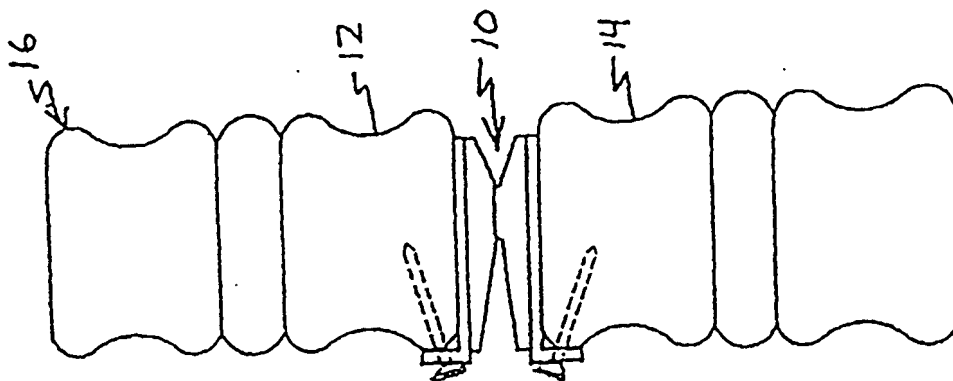


Fig. 2

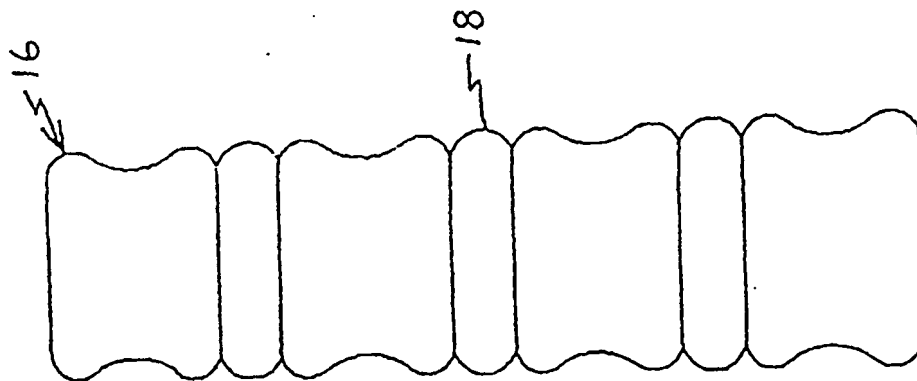
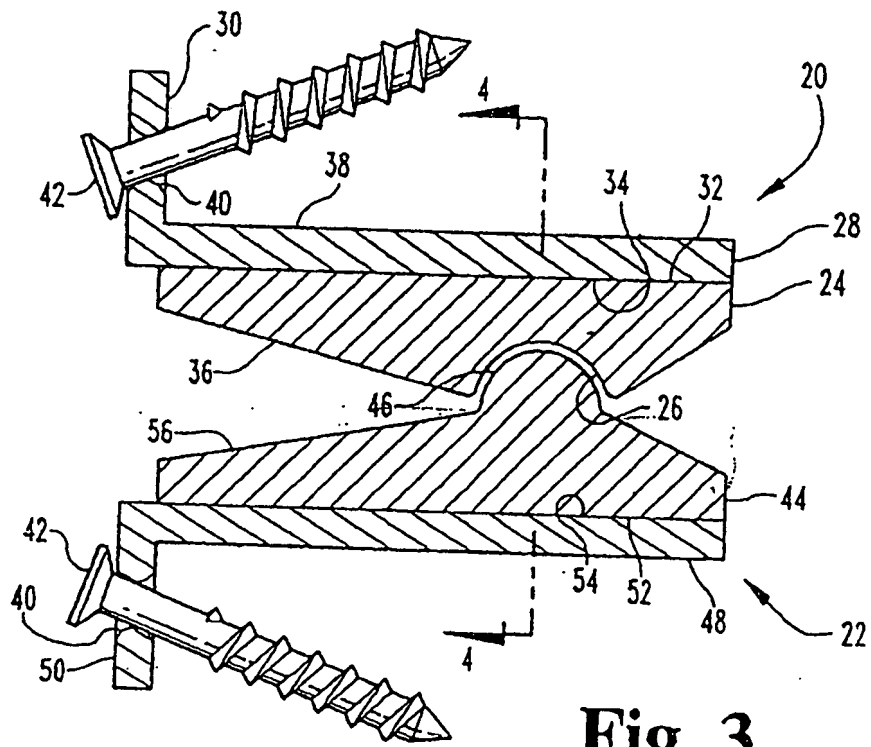
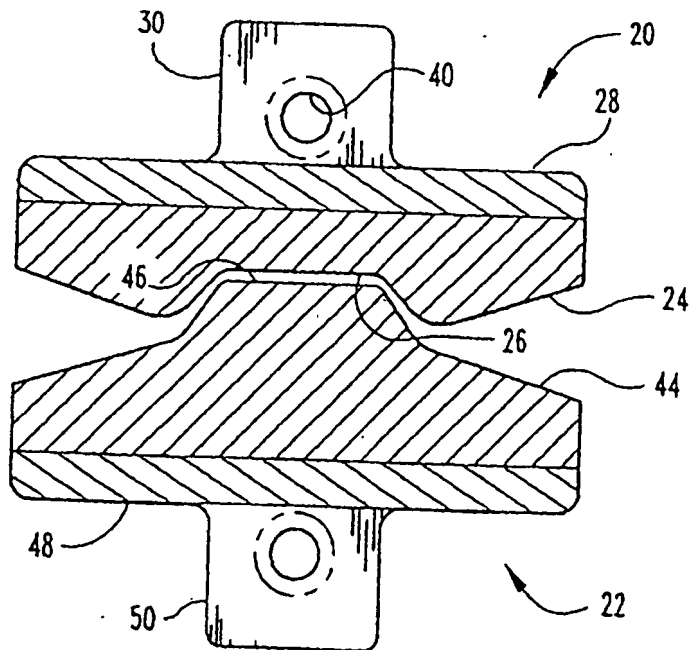


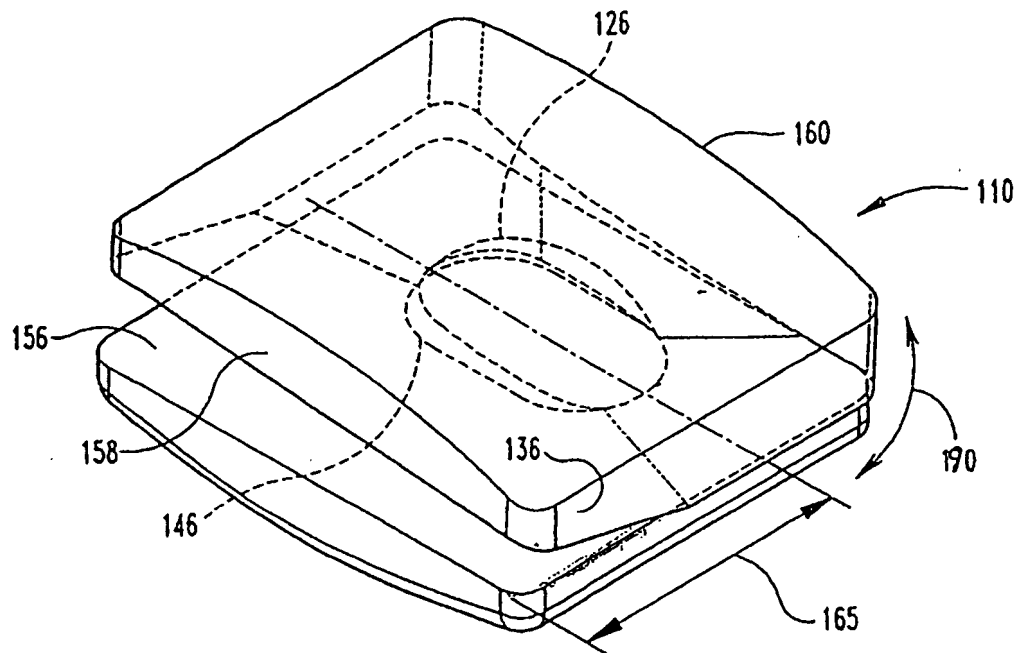
Fig. 1



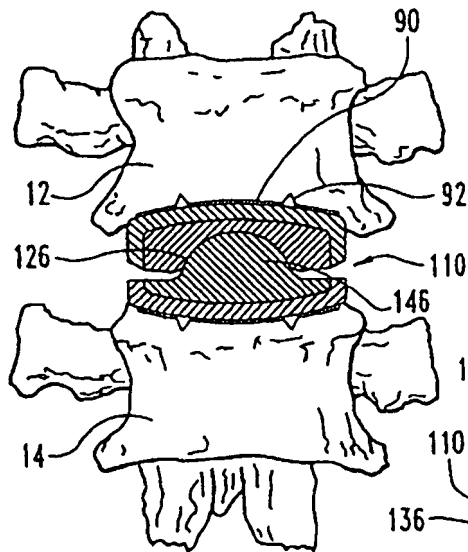
**Fig. 3**



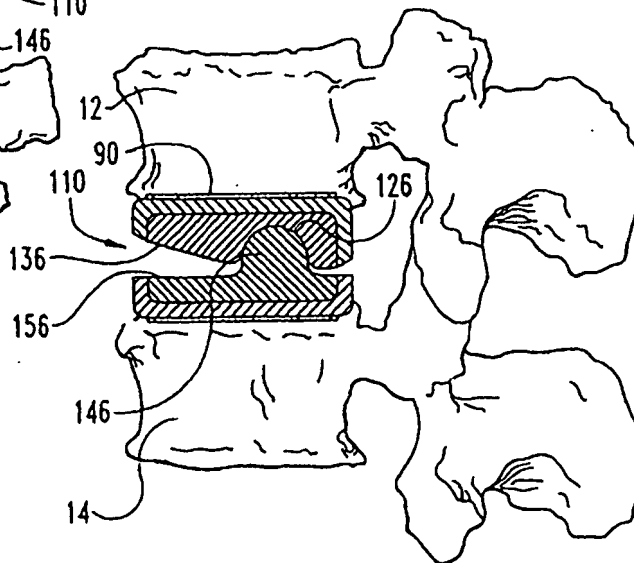
**Fig. 4**



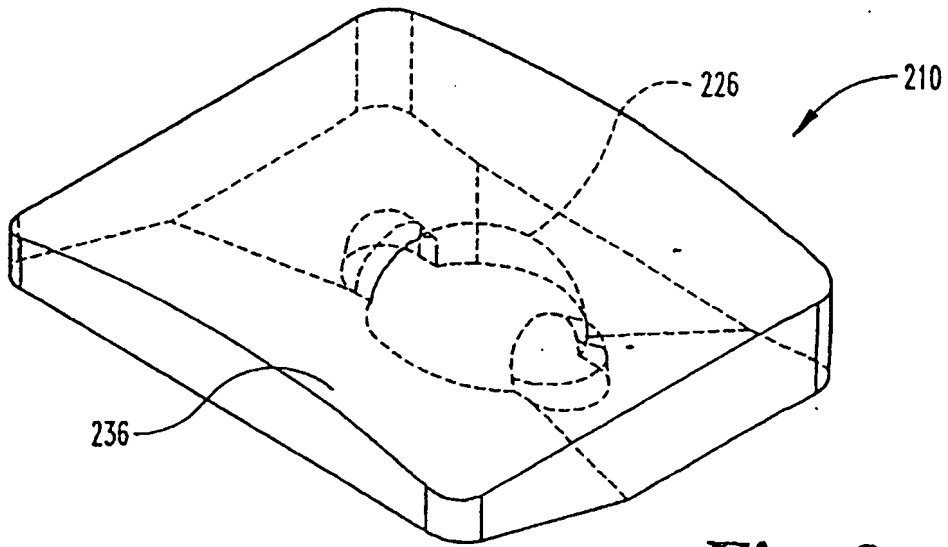
**Fig. 5**



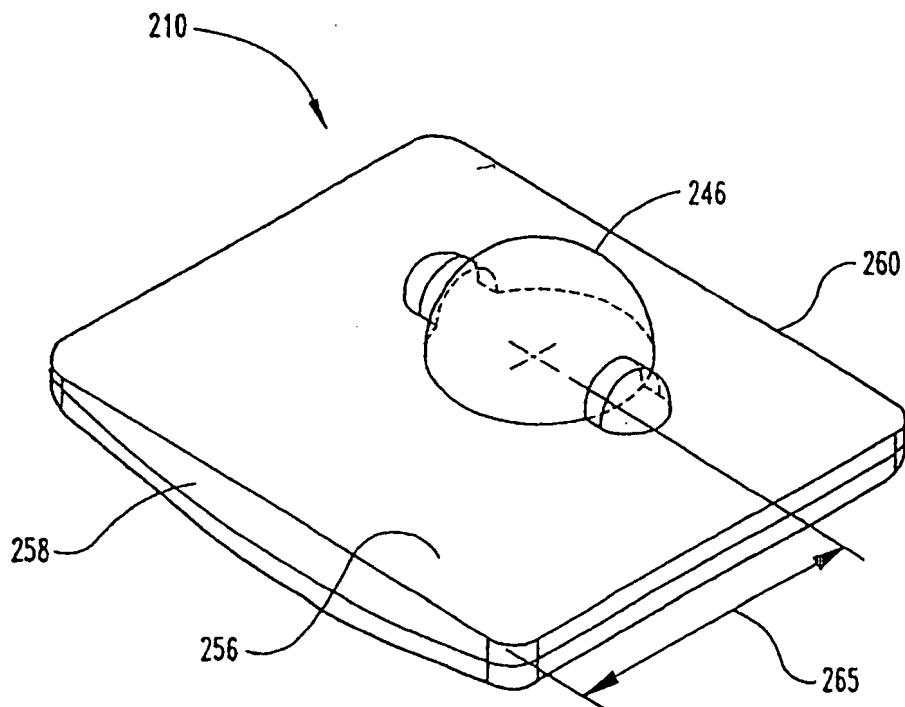
**Fig. 6**



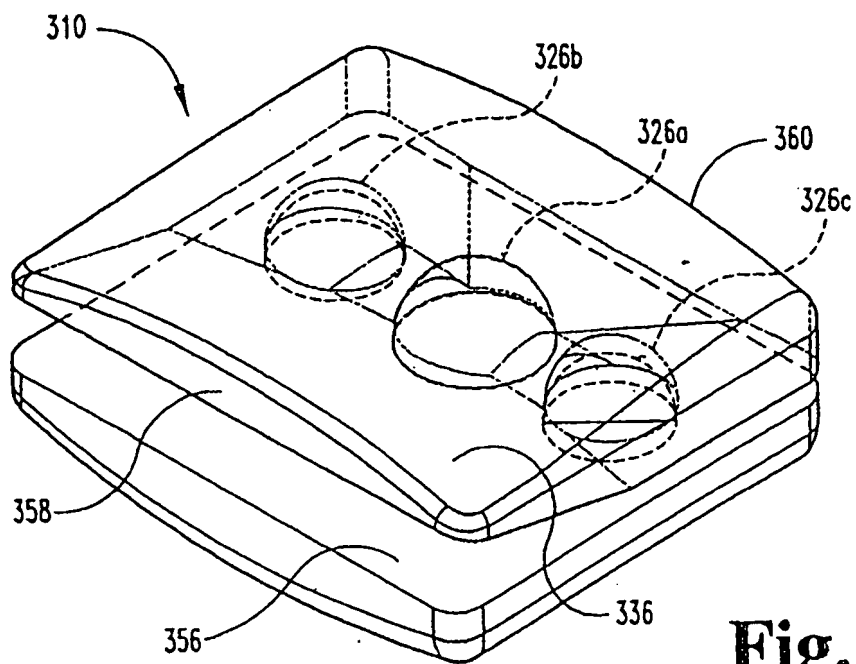
**Fig. 7**



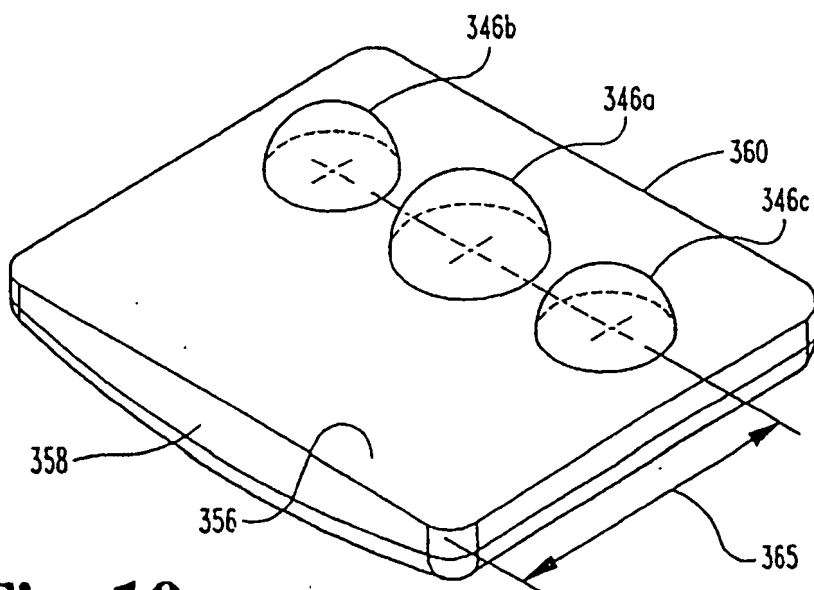
**Fig. 9**



**Fig. 8**



**Fig. 11**



**Fig. 10**

FIG. 12

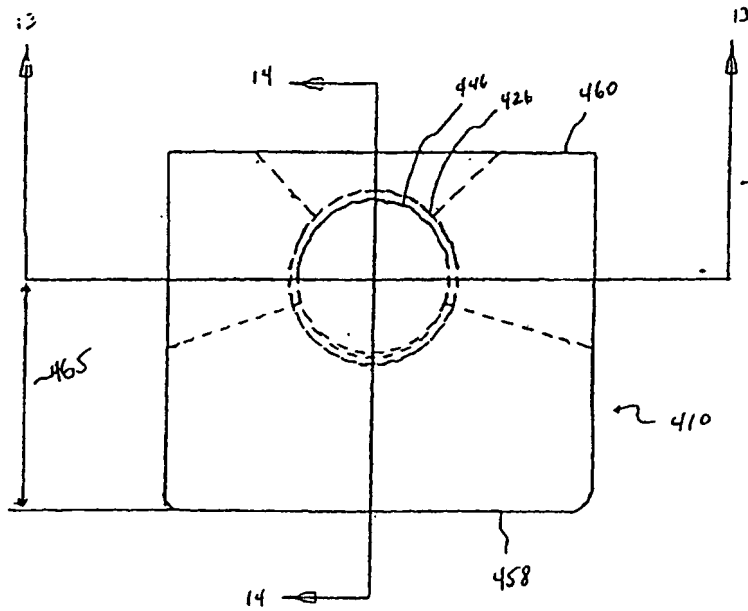


FIG. 13

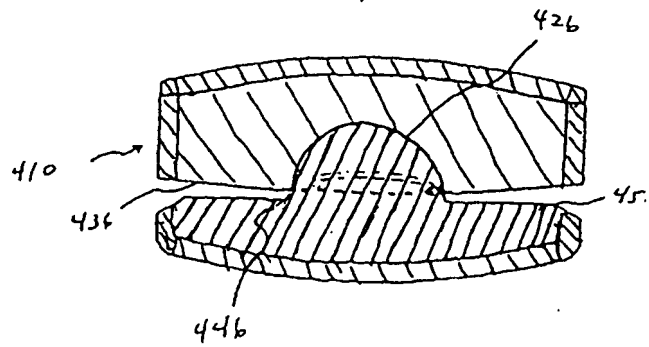
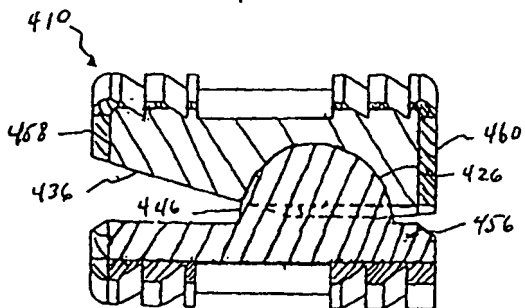


FIG. 14



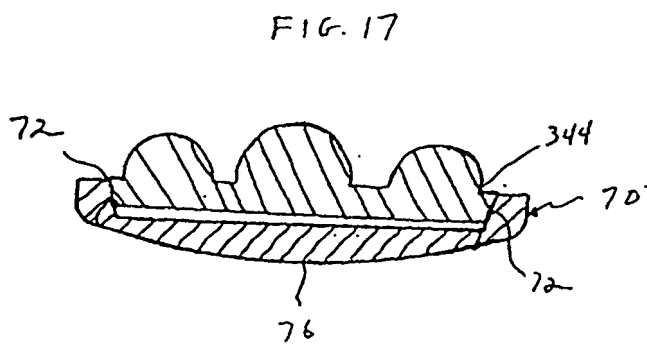
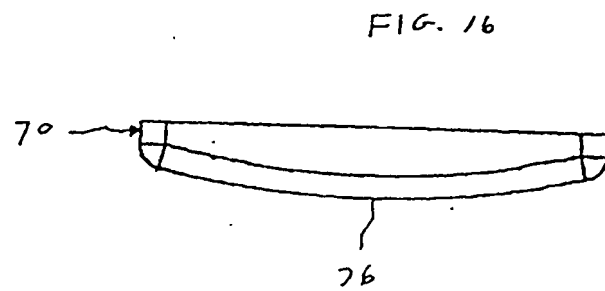
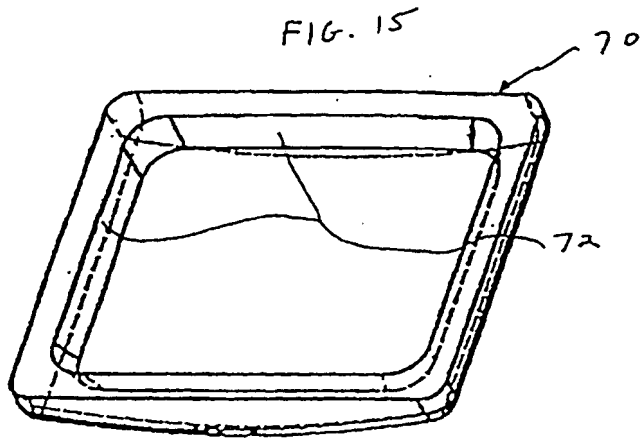


FIG. 18

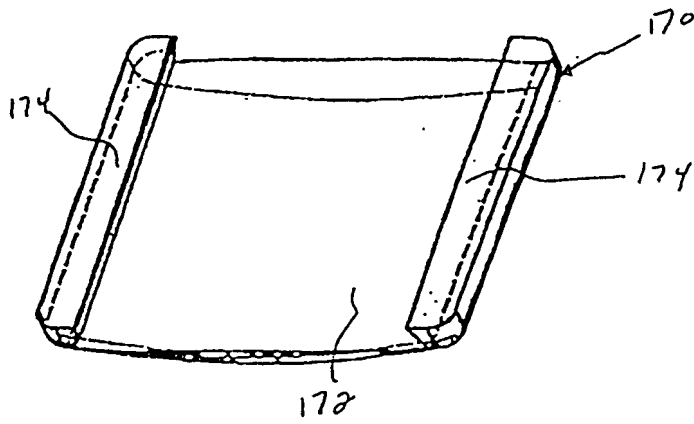


FIG. 19

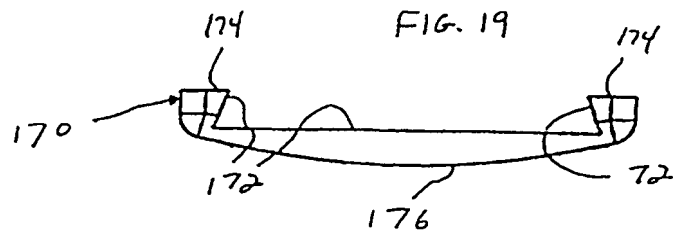


FIG. 20

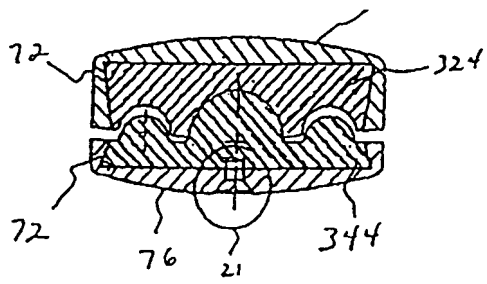
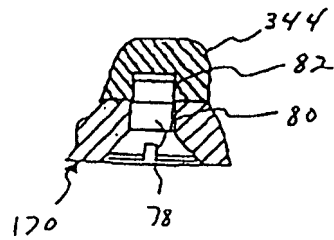
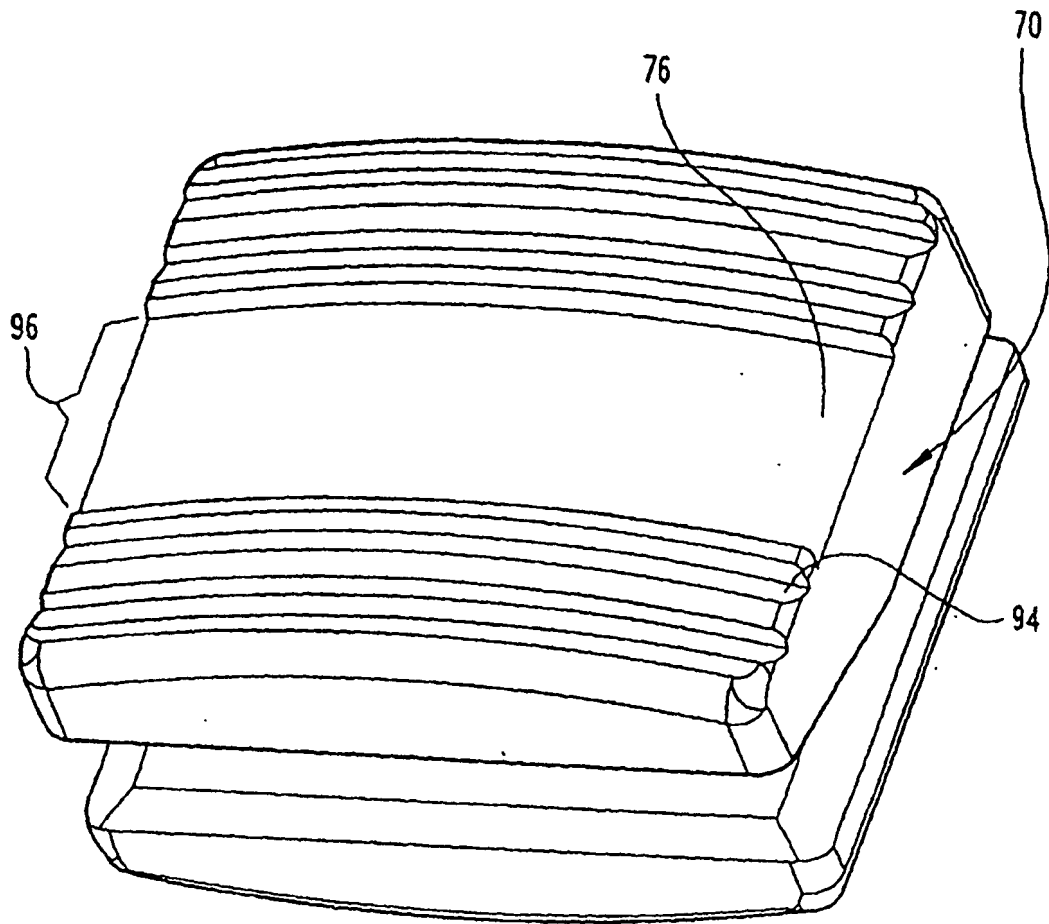


FIG. 21







**Fig. 22**